

Appendix G

Fisheries Management Plan

DRAFT

A FISHERIES MANAGEMENT PLAN FOR
LAKE DAVIS
PLUMAS COUNTY, CALIFORNIA



STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME



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The Resource Agency
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LAKE DAVIS

PLUMAS COUNTY, CALIFORNIA

2006

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Figure 1 Lake Davis and Big Grizzly Creek Watershed

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Appendix A History of the Lake Davis Fishery and Management

PURPOSE

The Lake Davis Fishery Management Plan outlines the history of the fishery, current fishery management and potential future fishery management plans. Two fishery management scenarios are presented; 1) a fishery management plan with northern pike not present in Lake Davis, and 2) a fishery management plan with northern pike present within Lake Davis.

INTRODUCTION

Since the initial impoundment of Big Grizzly Creek in 1967, the California Department of Fish and Game (DFG) has managed Lake Davis as a rainbow trout (*Oncorhynchus mykiss*) fishery. Many anglers have considered the reservoir to be one of the premier trout fisheries in California, if not the western half of the United States. The reservoir has demonstrated an ability to produce exceptional growth for stocked rainbow trout. It has been a popular destination for anglers from all over California and some of the surrounding states. Anglers using flies, bait, and hardware have enjoyed success in pursuit of quality rainbow trout.

The Lake Davis fishery was thoroughly studied in its early years, 1970s and 1980s, to determine the best strain and/or species of fish to provide a viable salmonid fishery (Powers, 2003). Like many new impoundment fisheries, the catch per hour (CPH) was extremely good, approximately 0.60 fish per hour in 1972. As is also common with aging reservoir fisheries the CPH diminished over time, to approximately 0.10 fish per hour in 1979 (Powers, 2003). Since the 1970s, the catch per hour has fluctuated between 0.20 and 0.30 fish per hour (Powers, 2003). Marginal water quality issues during the summer months have been a factor affecting salmonid survival and carry over. DFG biologists examined the possibility of having a salmonid and warmwater fishery but opted to stay with a high cost salmonid fishery and continued annual stockings of rainbow trout (Powers, 2003).

In 1994 northern pike, *Esox lucius*, were discovered to have been illegally introduced into Lake Davis. The ensuing population explosion of northern pike within Lake Davis had a negative impact on the rainbow trout population and a subsequent decline in fishing success, approximately 0.28 fish per hour in 1995 to 0.18 in 1997 (Powers, 2003). In October 1997, the reservoir was chemically treated by DFG with a piscicide (formulated and powdered rotenone) to rid Lake Davis of the northern pike. Following this treatment, the reservoir was heavily restocked in July of 1998 with various sized trout (fingerlings, sub-catchable, catchable and trophy sized rainbow trout) and fishing success once returned to approximately 0.30 fish per hour in 2000 (no DFG creel data collected in 1998 or 1999) (Powers, 2003).

Unlike the early 1990s, DFG undertook an aggressive “control and containment” program as outlined in “*Managing Northern Pike at Lake Davis: A Plan for Y2000*” (Y2000 Plan). The program was implemented in the spring of 2000 and used methods presented in the Y2000 Plan in an attempt to prevent explosive pike population growth as seen from 1994 to 1997 and to prevent escapement of pike from the reservoir. As part of this management plan, DFG discontinued stocking fingerling rainbow trout, as it was believed pike would have a negative impact on the survival of trout of this size. Beginning in 2000, the DFG implemented a

program of stocking approximately 50,000 catchable-sized rainbow trout each year in an attempt to maintain a viable trout fishery while various options on how to best deal with the presence of pike could be ascertained. As was seen in the period from 1994 to 1997, the CPH for rainbow trout declined steadily from 2000 to 2003 .

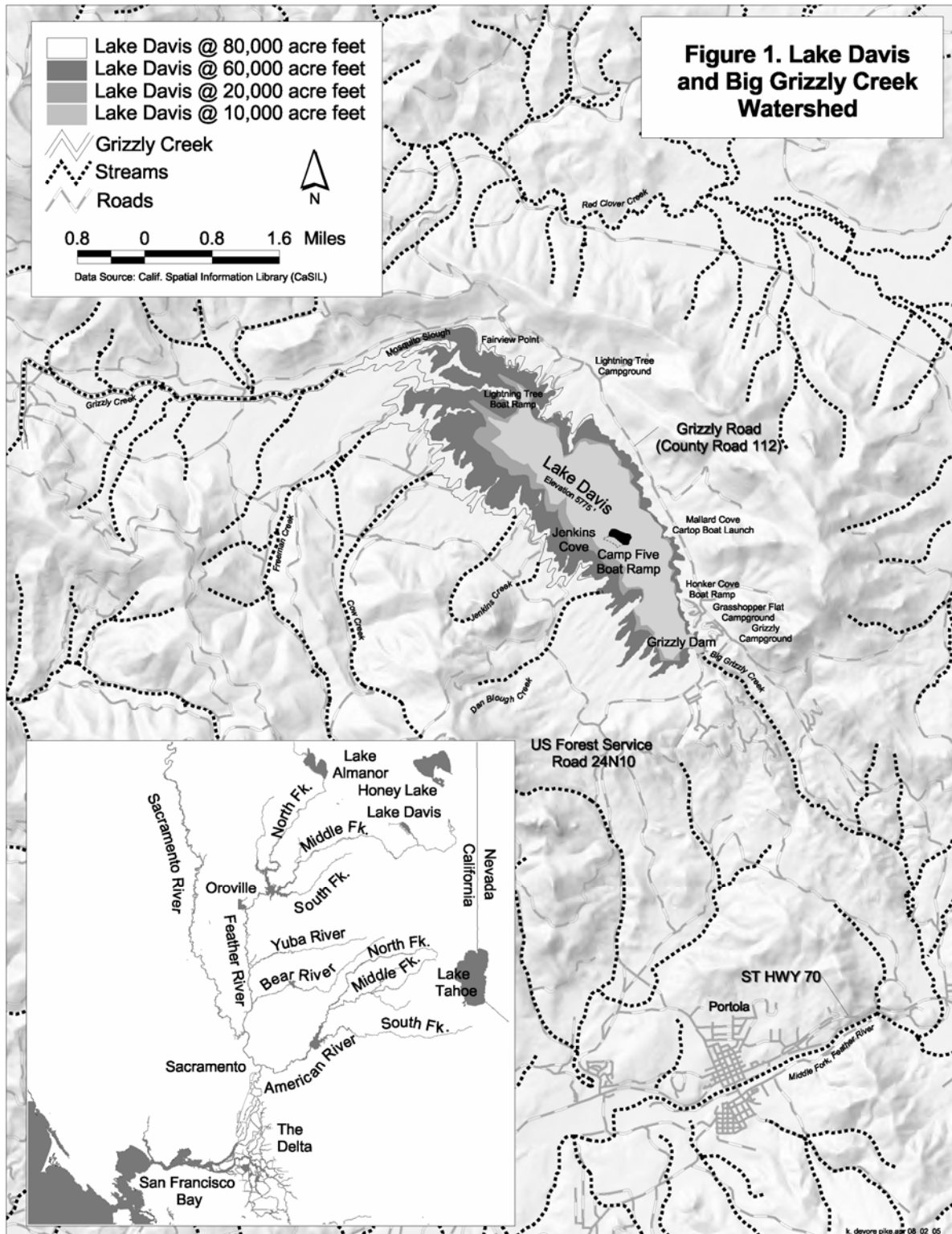
In 2003, the DFG prepared a summary report “*Managing Northern Pike at Lake Davis, A Plan for Year 2000: Three Year Report*” (Three Year Report) (CDFG, 2003) which evaluated the Y2000 Plan. The report indicated; 1) the pike population was increasing despite the aggressive program to remove as many pike from the reservoir as possible, 2) pike were most likely beginning to have an impact on the trout population, CPH dropped from approximately 0.30 to 0.12 (Powers, 2003), 3) the chances of the pike escaping naturally were increasing due to increased number and distribution of pike, and 4) the potential for illegal movement by humans was increasing due to larger number of pike present in Lake Davis, allowing for a better opportunity to capture and move pike.

In December 2003, the Lake Davis Steering Committee sent a letter to Secretary of Resources Michael Chrisman asking that the DFG begin investigating possible methods to rid northern pike from Lake Davis. Secretary Chrisman directed DFG to proceed in examining possible methods to rid Lake Davis of northern pike. In September 2005, DFG, issued a Notice of Preparation (NOP) and the US Forest Service, Plumas National Forest (USFS) issued a Notice of Intent (NOI) stating the agencies’ respective intentions to prepare a joint Environmental Impact Report/Environmental Impact Statement (EIR/EIS) for a proposed project to eradicate pike from Lake Davis. The proposed project would involve reducing reservoir storage to 10,000 - 20,000 acre feet and then treating Lake Davis and its tributary streams with a formulated rotenone piscicide. In addition to the proposed project, the joint EIR/EIS will evaluate alternatives. The joint EIR/EIS is being prepared with the assistance of a private consulting firm under contract with DFG.

RESOURCE STATUS

General Setting

Grizzly Valley Dam which impounds Big Grizzly Creek and forms Lake Davis, was authorized for construction as part of the State Water Project by the Burns-Porter Act which was approved by the California voters November 8, 1960. Grizzly Valley Dam was constructed in 1967 (Figure 1). Lake Davis is owned and operated by the California Department of Water Resources (DWR).



At spill elevation of 4,775 feet, Lake Davis is a 4,026 surface acre reservoir situated on the eastern slope of the Sierra Nevada Mountains in eastern Plumas County, California. When full, the reservoir is capable of impounding 84,371 acre feet of water with a mean depth of approximately 20 feet. It has a drainage area of 44 square miles, with an average annual inflow of approximately 35,000 acre feet (range of 7,500 to 60,000 acre feet) (DWR web site). Three perennial tributaries feed Lake Davis, Big Grizzly Creek, Freeman Creek and Cow Creek, with Big Grizzly Creek being the main tributary. Several seasonal and intermittent streams flow into the reservoir during spring snow melt.

Lake Davis is located entirely within and on Federal lands owned and managed by the USFS, with the exception of a small portion of land on and near Grizzly Valley Dam which is owned by DWR. There are private parcels situated within an approximate ¼ mile distance along the southwestern end of the reservoir. Three USFS campgrounds and three boat launch sites are located along the eastern shore along with four vehicle fishing access points. One boat ramp and four vehicle fishing access points are found along the western shore. A paved county road runs along the southern and eastern northern sides of the reservoir with a graveled USFS road running along the western side.

History of the Fishery

Following the impoundment of Big Grizzly Creek in 1967, DFG planted Lake Davis with large numbers of rainbow trout and cutthroat trout (*Oncorhynchus clarki*) fingerlings. The fishery flourished using this management plan until the mid 1970s when a severe decline in harvest was noted. It appeared that poor survival of the fingerlings was attributable to winter kills and poor water temperature parameters and water quality during the summer months. In addition, three illegally planted species of fish, golden shiner (*Notemigonus crysoleucas*), brown bullhead (*Ameiurus nebulosus*), and largemouth bass (*Micropterus salmoides*) were present in the reservoir by the mid 1970s and most likely were having an impact on trout survival (Powers, 2003).

The golden shiner and brown bullhead populations continued to increase through the 1970s and 1980s. DFG evaluated the use of physical fish removal to reduce the fish biomass. Such a program would be extremely expensive and labor intensive and would most likely prove unsuccessful, hence it was not undertaken (Powers, 2003).

From the mid 1970s to 1980 DFG experimented by stocking various salmonid species and sizes to determine if the Lake Davis fishery could be improved by managing for different trout species/strains. Fish species evaluated and determined not to improve the fishery included Chinook salmon (*Oncorhynchus tshawytscha*), Coho salmon (*Oncorhynchus kisutch*), brown trout (*Salmo trutta*), and a cutthroat/rainbow trout cross (*Oncorhynchus mykiss x Oncorhynchus clarki*). Eagle Lake rainbow trout (*Oncorhynchus mykiss aquilarum*) demonstrated a higher survival rate and ability to forage on the golden shiners (Powers, 2003).

DFG contemplated several management options in 1980, including possible treatment of the reservoir to remove the golden shiners and bullheads and restocking with rainbow trout, or changing the managed fishery from rainbow trout to a warmwater fishery. After much

deliberation, DFG decided to manage Lake Davis as a high cost, low yield trophy trout fishery. Stocking of fish changed from fingerling and sub-catchable-sized trout to catchable-sized trout at a rate of 10 fish per surface acre ($10 \times 4,000 = \sim 40,000$ trout per year). The Eagle Lake strain was selected as the most likely fish to be able to provide the desired fishery. In addition, DFG made occasional stockings of brown trout to provide a limited, but diversified fishery (Powers, 2003).

From 1980 to 1994, DFG was able to maintain a viable trophy trout fishery but the program continued to be complicated by the illegal introductions of various fish species. Besides the golden shiners, brown bullheads and largemouth bass, pumpkinseed sunfish (*Lepomis gibbosus*), bluegill (*Lepomis macrochirus*), black bullhead (*Ameiurus melas*), Sacramento sucker (*Catostomus occidentalis*), Lahonton redbreast (*Richardsonius egregius*), fathead minnow (*Pimephales promelas*), speckled dace (*Rhinichthys osculus*), and Sacramento perch (*Archoplites interruptus*) were found in the reservoir (Powers, 2003).

In 1994, northern pike were discovered in Lake Davis and DFG moved quickly to develop a plan to eradicate the pike. During the time frame to develop an eradication plan, 1994 to treatment in 1997, the catch rate for trout dropped from 0.27 trout per hour in 1995 to 0.15 in 1997 (Powers, 2003). The reservoir was treated in October of 1997 to remove the pike.

In July of 1998, after all traces of the chemicals in the piscicide were gone, DFG restocked the Lake Davis with rainbow trout varying in size from fingerling to trophy size. In addition, a small number of fingerling and trophy-size brown trout were stocked in the reservoir. The tributaries were stocked with fingerling brook trout. DFG did not conduct angler surveys during 1998 and 1999. Limited angler surveys by DWR in 1998 indicated a catch rate of 0.21 trout per hour (Powers, 2003).

In May of 1999, pike were once again confirmed to be present within the reservoir. DFG and the local community worked to develop a management plan for dealing with the presence of pike. DFG ceased stocking of fingerling fish to reduce predation on the trout by the pike and implemented the catchable stocking program previously used. A total of 50,000 catchable-size trout were planted from 2000 through 2003. DFG began angler surveys in 2000 to evaluate affects of pike on the trout fishery. The catch rate in 2000 was 0.28 trout per hour and diminished each year through 2003 to 0.12 (Powers, 2003). This trend was similar to 1994 through 1997 when pike were present in Lake Davis.

Current Fishery

The DFG has continued to manage the reservoir as a rainbow trout fishery by stocking 50,000 catchable sized trout (two fish to the pound and approximately 10 inches long) each year from 2000 through 2003. In 2004, the planting allotment was reduced by 30 percent to 35,000 catchable size rainbow trout due to budget constraints on DFG and the subsequent reduction in hatchery production. In 2005, the stocking rate was also 35,000. A total stocking of 35,000 rainbow trout is scheduled for the 2006 trout planting allotment.

Other fish species present within the reservoir following the 1997 treatment include the brown bullhead, pumpkinseed sunfish and golden shiners. Although no definitive answer

can be given as to why these fish are present in the reservoir following the treatment, it can be surmised that either 1) they survived the treatment due to their higher tolerance to rotenone; 2) they were illegally restocked following the treatment; or 3) a refugia existed within the watershed which may not have been treated, thus allowing for their survival. Several adult largemouth bass were sampled in the summer of 1999, indicating they most likely had been illegally planted following the 1997 treatment.

In 2000, the DFG stocked approximately 1,053 brood-stock-sized brown trout (fish weighing 3 to 5 pounds) as a potential predator on the northern pike. Very few of the brown trout were harvested by anglers as few anglers targeted them specifically. No evidence was available to indicate whether or not the brown trout preyed on the pike.

Following the 1997 treatment, the DFG stocked brook trout (*Salvelinus fontinalis*) in Freeman Creek and Cow Creek and subsequent electrofishing of these creeks in the years 2000 to 2005 indicated the brook trout have established a reproducing population. They provide a popular stream fishery for a small number of anglers.

ENVIRONMENTAL PROBLEMS/ISSUES

Northern Pike

Northern pike are a non-native invasive species. The pike are currently contained within Lake Davis and no evidence has been found to indicate their existence in other bodies of water within the State of California. The presence of northern pike has serious implications for the trout fishery of Lake Davis, as well as other waters of the State of California. Because they are a very adaptable species of fish with a wide range of physical tolerances, it is imperative that they be eliminated from Lake Davis to prevent further spread throughout the state.

MANAGEMENT PROGRAM

The Fishery Management Plan covers two possible scenarios for Lake Davis; 1) manage a pike-free Lake Davis following a pike eradication project, and 2) manage Lake Davis with pike remaining in the reservoir.

Pike-Free Management Plan

Management Goals

Post Treatment. The goal for the Lake Davis fishery is to provide a high quality trout angling opportunity within Lake Davis and the streams flowing into the reservoir.

Management Objectives

Post Eradication. The objective of stocking trout in the fall and following spring is to develop a catch rate of 0.30 to 0.50 catchable size trout per hour (determined by creel surveys) in the spring and summer following eradication of pike from the reservoir.

Long Term. Annual stocking of catchable-sized rainbow trout will continue after the initial restocking efforts. The objective of the long-term fishery management plan is to develop and maintain a rainbow trout fishery which provides an average catch rate 0.30 trout per hour or greater and rainbow trout with a total average length of 15 inches or greater. The annual catch per hour for an angling season from April through October (based on angler creel surveys) will be used to determine stocking rates for the upcoming year.

Fishery Management Elements

Re-stocking Lake Davis/Tributaries

Post Eradication (Lake Davis). In the event eradication involves a chemical treatment of Lake Davis, during and following the eradication of pike from the reservoir, live cars containing rainbow trout will be suspended at various water depths throughout the reservoir to determine when reservoir water is no longer toxic to trout. Once it has been determined the water is clear to plant the trout, catchable size or larger rainbow trout will be stocked into Lake Davis at a rate of 5 fish per surface acre. The stocking rate, 5 versus 10 fish per surface acre, is based on the probability of a short term reduced forage base in the reservoir following eradication. In addition to immediate post eradication stocking, additional stocking will occur in the spring following ice-out and will consist of an assortment of various sized trout. Trout stocked in the spring will consist of fingerling, sub-catchable, catchable and trophy (>3 pounds) sized fish, based on availability of trout. Recommended stocking rates for the various sizes of trout include: fingerlings, 230 per surface acre; sub-catchables, 50 per surface acre; catchables, 30 per surface acre; and trophy size, 0.1 per surface acre.

In addition to rainbow trout, brown trout adults (~ 3 pounds and greater) will be stocked in the reservoir. Recommended stocking rate is: 0.1 fish per surface acre.

Post Eradication (Streams). Fingerling brook trout could be restocked in Freeman Creek and Cow Creek at a stocking rate recommended by DFG reservoir fishery managers. In addition to the brook trout, fingerling rainbow trout would be stocked in Big Grizzly, Cow, and Freeman creeks.

Long Term. The recommended annual stocking rate for rainbow trout is 10 to 12 catchable size trout per surface acre. Creel survey data will be used to evaluate stocking rates. The data may indicate changes, either more or less trout per surface acre, to satisfy the objectives of maintaining a catch rate of 0.25 trout per hour with an average total length of 15 inches.

Monitoring the Fishery

To monitor the fishery in Lake Davis, the DFG will conduct creel surveys at the reservoir to determine angling success. The surveys will be conducted approximately eight (8) days per month consisting of 75 percent weekdays and 25 percent weekend/holidays. The surveys will commence in April and be conducted each month through October for a minimum of two years post-treatment. The creel survey data will be summarized at the completion of the seasons creel survey work to determine the annual CPH for trout.

Generally speaking, it is expected the CPH will be higher in April and May and September and October of each year. The CPH typically drops through June and is often lowest in July and August due to warm water conditions.

The annual CPH figures will be used by fishery managers to make management decisions for the following year's trout stocking rates.

Angling Regulations

The angling regulations for Lake Davis should continue to be the same as are now in effect, open to angling all year with a limit of 5 fish per person per day and 10 in possession.

Management Alternatives Considered

There have been several suggestions that Lake Davis should be managed as a warmwater fishery. Some anglers living in the general area would like to see a bass fishery developed. This suggested alternative is problematic because Lake Davis provides a very short growing season for warmwater fish and consequently poor growth rates. The majority of the anglers prefer a rainbow trout fishery. Managing Lake Davis as both a trout and warmwater fishery would very likely lead to less than optimal results for both fisheries.

Pike Present Management Plan

Management Goals

The fishery management goal with Lake Davis containing pike would be to provide recreational opportunities to the degree possible while preventing pike from posing additional threats to California's natural resources.

Management Objectives

Because the serious threat that pike pose to many of the other fishery resources within the state, the main objective is to prevent a person or persons from catching and illegally moving pike to other waters within California, and to minimize the chance that the reservoir will spill and release pike to downstream waters. DFG will continue to manage Lake Davis as a fishery as long as it is believed that a fishery can be maintained without undue risk of pike escapement.

Fishery Management Elements

Stocking Lake Davis

It is recommended that all stocking of salmonids in Lake Davis and its tributaries continue under the current stocking regime so long as it is believed that a fishery can be maintained without undue risk of pike escapement.

Monitoring the Fishery

To monitor the fishery in Lake Davis, the DFG will conduct creel surveys at the reservoir to determine angling success. The surveys will be conducted approximately eight (8) days per month consisting of 75 percent weekdays and 25 percent weekend/holidays. The surveys will commence in April and be conducted each month through October for a minimum of two years post-treatment. The creel survey data will be summarized at the completion of the seasons creel survey work to determine the annual CPH for trout. Generally speaking, it is expected the CPH will be higher in April and May and September and October of each year. The CPH typically drops through June and is often lowest in July and August due to warm water conditions.

The annual CPH figures will be used by fishery managers to make management decisions for the following year's trout stocking rates.

In addition to the creel surveys, spring and fall sampling programs will be conducted at Lake Davis to determine the status of the northern pike population, as well as other fish populations within the reservoir and its tributaries. In addition, sampling will be conducted on the lower reaches of Big Grizzly Creek and reaches of the Middle Fork Feather River from Sierra Valley downstream through Portola to determine if any pike have escaped from the reservoir.

Angling Regulations

Angling regulations will remain the same as current regulations at Lake Davis and its tributaries so long as it is believed that a fishery can be maintained without undue risk of pike escapement.

Management Alternatives Considered

Suggestions have been made to either manage Lake Davis as trophy trout/trophy pike fishery or a trophy pike fishery. The configuration of Lake Davis, with its extensive shallow water habitat and weed beds and lack of refugia for trout, does not provide the type of environment in which trout and pike could coexist and develop into trophy fisheries. In addition, pike biologists have characterized Lake Davis as the type of water body that would create a stunted pike ("hammer handle") fishery over time. This is due to the extensive suitable spawning areas and eventual limited food supply as the pike population increase

Of critical importance is that the presence of northern pike poses a threat to many of the other fishery resources within the state. History has demonstrated that humans will move fish species from one body of water to another, either inadvertently or intentionally. The Lake Davis pike population represents a danger to California's aquatic ecosystems since it is such a readily available source population. With the continued presence of pike in Lake Davis and a legalized fishery, it will only be a matter of time before pike are moved to other bodies of water. There is also the risk of downstream movement through the dam outlets or reservoir spillway.

Managing Lake Davis as a trout/pike and or pike fishery is not biologically viable and would threaten fishery resources throughout California. If pike remain in Lake Davis in large numbers, DFG may need to consider managing Lake Davis differently than in the past.

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APPENDIX A

HISTORY OF THE LAKE DAVIS FISHERY AND MANAGEMENT

By

**Lori Powers
Biologist, Marine/Fisheries
Department of Fish and Game**

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History of the Lake Davis Fishery and Management

Prior to impoundment in 1967

Before the Lake Davis reservoir was created, biologists surveyed sections of Big Grizzly and Cow Creeks that were within the proposed impoundment site to determine the species of fish present. The creeks were found to contain only rainbow trout (*Oncorhynchus mykiss*). No other game or non-game fish species were found. Below the proposed dam site, Big Grizzly Creek contained rainbow trout, suckers (*Catostomus* spp.), and speckled dace (*Rhinichthys osculus*).

1967-mid 1970s

Lake Davis was impounded in 1967. The California Department of Fish and Game (Department) planted over 1.5 million rainbow trout and 100,000 cutthroat fingerlings from 1967-1968. (See Figures 1 and 2 for history of trout stocking at Lake Davis. Figure 1 compares the numbers of trout. Figure 2 compares the total pounds of trout planted each year.) The reservoir was opened to fishing in 1968. Until the mid 1970s, the Department managed the reservoir as a “put and grow” fishery. (See Figure 3 for history of management of the reservoir’s fishery and the timeline of occurrence of fish species.) Under this type of management plan, hatcheries raised trout from egg to fingerling stage. The small fish were planted in the reservoir to continue growing to catchable-size. Annual stocking ranged from 700,000 to one million fingerlings and 50,000 to 100,000 sub-catchables. A small number of catchables were planted. Approximately 100,000 brook trout (*Salvelinus fontinalis*) fingerlings were planted in the first years to establish another popular fishery. The Department experimented with a wide variety of strains and sizes of RT to find the best stock choice for growth, survival, and return to creel.

Early angler success at Lake Davis was phenomenal. The small fish that were planted grew rapidly on the reservoir’s rich plankton and invertebrate “soup”. Fisheries managers estimated annual yield up to 650,000 RT, with 40 pounds harvested for each pound stocked. It was not uncommon to observe 10,000 anglers enjoying fishing at Lake Davis during a weekend. Angler catch rate averaged as high as 0.60 fish per hour in some years. (See Figure 4 for history of angler catch rate and Figure 5 for comparison of angler-caught trout sizes from 1970-2003). (See Appendix A for description of angler survey methods.)

Mid 1970s to 1980

In the mid 1970s, problems with the fishery became apparent as biologists noted dramatic decline in harvest during angler surveys. Harvest dropped steadily from an estimated 120 lbs per acre in 1970 to less than 2 lbs per acre by 1978. By 1980, a low of 0.10 fish per hour was recorded for angler success.

The reservoir was plagued by low survival of fish of all size classes, especially fingerling, sub-catchable sizes, and larger catchables. In some years, it appeared that winter mortality

was substantial. In other years, summer mortality was the more significant factor. Fisheries managers estimated 60% winter mortality among adult trout. Sub-catchables showed somewhat better winter survival and growth but high summer mortality. Planted fingerlings showed extremely low return to creel in subsequent years. While some natural reproduction occurred in the reservoir tributaries, biologists estimated the fishery to be 95% hatchery-sustained.

Speculation about the causes of the decline in the Lake Davis fishery produced several theories. It is a typical pattern for a new reservoir fishery to experience an initial high rate of return to creel and harvest during the years immediately following impoundment and filling. As the reservoir ages, the flush of high productivity from the newly inundated landscape wanes, and the fishery declines in terms of yield of fish biomass to anglers. Given specific characteristics of the productivity and basin shape of Lake Davis, biologists estimated that the yield would eventually settle out and be sustainable at about 20 lbs per acre. Consequently, some eventual decline in the fishery was anticipated. However, the extent and speed of the decline were higher than expected.

The Department examined other factors that could contribute to the observed decline. Three illegally introduced fish species were discovered in Lake Davis. Golden shiners (*Notemigonus crysoleucas*) were noted in profusion in 1972. Brown bullhead (*Ameiurus nebulosus*) began showing up in creel censuses in 1974. Largemouth bass (*Micropterus salmoides*) were first reported in 1978. As the populations of the newly introduced species grew, these fish potentially could compete with trout for food and habitat. Some could also prey on small trout. By 1980 it was estimated that the reservoir's fish biomass was 70% shiners, 20% bullheads, and 10% trout.

In 1980, the Department and the University of California, Berkeley, cooperated on a two-part study. One part aimed to determine the potential for competition between trout and shiners and bullhead. Part two examined the limnological characteristics of the reservoir that might limit survival or distribution of trout. The study found little evidence of competition between trout and shiners and virtually none between trout and bullhead at the time of the study. However, the study covered only one year, and results were inconclusive. It was suggested that as populations grew and fluctuated with annual weather conditions, more competition could be expected.

The limnological study revealed that deeper areas of the reservoir do not contain enough oxygen to support trout during the summer. High water temperatures and increased ammonia levels in shallower waters also may exceed limits for trout health. During several weeks to several months in the summer each year, trout must move between deeper waters with critically low oxygen and shallow waters which present dangerous thermal and toxic conditions. The study suggested that these stressful conditions negatively affected trout survival, growth, and angling return. The largest effects on trout survival would be experienced in years of below average reservoir water levels. The study also suggested that erosion of the shoreline and livestock grazing contribute to the negative effects by increasing the nutrient supply in the reservoir.

MANAGEMENT ATTEMPTS TO ADDRESS FISHERIES PROBLEMS

The period of mid 1970s to early 1980s was one of experimentation for managers at Lake Davis. Put-and-grow management was no longer working. Due to the high natural mortality of stocked fish and low return to angler creels, the Department considered different management options to address the various factors suspected in the decline of the fishery. An early step was to reduce the catch limit from ten to five trout per angler per day to share equitably the resource among anglers and to prevent over-harvest while fortifying the fishery. Managers experimented with stocking various species of salmonids at different times of the year in order to select the best species and strain of trout or salmon, the best size to plant, and the best time to plant to achieve the greatest survival and return. The size of rainbows planted was adjusted to include fewer small fingerlings and more large sub-catchables. Cutthroat-rainbow (*O. clarkii x mykiss*) crosses, brown (*Salmo trutta*), and Eagle Lake (*O. mykiss aquilarum*) trout were introduced to test if these species would show better survival and return in the conditions of Lake Davis. King (*O. tshawytscha*) and Coho (*O. kisutch*) salmon were also planted. King salmon were planted to provide a new fishery, as well as to utilize the forage base provided by the golden shiners.

Results from the experimentation were mixed. Growth, survival, and return to creel were very low for Coho and king salmon as well as for brown and cutthroat trout and cutthroat crosses. Catchable-size Eagle Lake trout showed higher winter survival. Biologists surmised that trout that converted to feeding on golden shiners had better survival.

The biomass of shiners and bullheads continued to grow. Managers were concerned over increasing competition with and negative impacts on trout. Shiner and bullhead reproduction were believed to be virtually unlimited. In order to control the populations of these species, biologists considered removal of fish by physical means. They estimated that this would require removal of 4 tons of aged stock per day for 5 months each year in order to keep up with reproduction, to exert control on the growth of shiner and bullhead populations, and to increase growth and survival of planted trout. Methods that could remove 4 tons of fish per day were not known so this idea was not further pursued.

By 1980, the Department had tried most available species and races of salmonids in planting Lake Davis. Low success in terms of yield prompted the Department to take a hard look at the future course for management of Lake Davis. Biologists considered several options. Treating the reservoir with a piscicide to eliminate the undesirable species and restocking with trout was one option. Abandoning trout planting and converting the reservoir to a warmwater fishery with some combination of bass, striped bass (*Morone saxatilis*), catfish (*Ictaluridae spp.*) or sunfish (*Centrarchidae spp.*) species was also examined. Letters received from the public while Department biologists deliberated indicated a majority of those responding favored converting the reservoir from a trout fishery to a bass fishery or a trout and bass combination fishery.

After careful consideration, the Department decided to manage Lake Davis as a high cost, low yield trophy trout fishery. (The Department doesn't have a formal definition for

management for a “trophy trout fishery”, but generally this refers to planting catchable-size trout with the expectation that some would be caught in the first year and some would survive and grow, providing anglers with larger, “trophy-size” fish in subsequent years.) Due to very poor survival and return, fingerling plants of rainbows were mostly discontinued. The management plan called for stocking catchable-size trout at a rate of ten fish per surface acre, the generally accepted rate for managing trophy trout lakes. This amounted to 40,000 catchable-size trout per year for Lake Davis. Emphasis was placed on stocking Eagle Lake trout as they showed the best survival and growth among the species and races tried. Because of poor growth and return rates, hatcheries discontinued the experimental stocking of other salmonids, with the exception of occasional limited plants of brown trout. Although planting brown trout resulted in very low yield and was not considered economical for the Department, a limited planting program was adopted to offer a diverse fishery.

1980 to 1994

From 1980, the Department successfully worked to maintain Lake Davis as a viable trophy trout fishery but with continuing difficulty. Through the 1980s and 1990s, golden shiner and bullhead populations thrived. Largemouth bass numbers also increased and were exploited by local anglers. Other fish species that could compete with or prey upon trout found their way into the reservoir sometime prior to 1997. These included pumpkinseed sunfish (*Lepomis gibbosus*), bluegill (*Lepomis cyanellus*), black bullhead (*Ameiurus melas*), Sacramento sucker (*Catostomus occidentalis*), Lahonton redbside shiner (*Richardsonius egregius*), fathead minnow (*Pimephales promelas*), speckled dace, and Sacramento perch (*Archoplites interruptus*). Until the mid 1980s, the Department stocked Lake Davis with the annual allotment of catchable-size trout and an average of 200,000 sub-catchables. A fall plant of over a million fingerlings in 1983 produced virtually zero return to anglers. In the late 1980s and 1990s, the Department cut back on sub-catchable and fingerling plants. Hatchery production was at capacity, and hatchery management shifted some production to rearing fewer fish but to larger size before planting in many waters statewide. Occasional plants of sub-catchables and fingerlings were used to augment the stock at Lake Davis. Angler harvest rates varied from year to year in this time period, with a general overall declining trend. Angler success ranged from a high of 0.37 trout per hour to a low of 0.10 trout per hour. Fish tagging studies indicated that rainbow trout returns dropped from an estimated 50% of fish stocked in 1980 to approximately 12% in 1986. The Department’s required minimum return of 50% when stocking catchable-size trout was no longer being met.

In 1983 the Department and Feather River College collaborated on a project to rear trout from eggs collected from Lake Davis trout attempting to spawn in the reservoir’s small tributaries. Fry were then released back to Lake Davis. It was hoped that this could lead to development of a strain of fish more adapted to and better able to thrive in Lake Davis conditions. Tagging studies of these fish showed no improvement in performance over Eagle Lake trout from other sources.

1994-1997

In 1994, the Department confirmed the presence of northern pike (*Esox lucius*), a top predator fish, in Lake Davis. Because of the non-native fish's predatory nature and lack of natural enemies in western waters, biologists recognized the pike's presence in Lake Davis as a serious threat to the reservoir fishery and to other state waters. From 1994-1997, they tried to maintain the trout fishery at Lake Davis while they searched for solutions to eradicate pike from the reservoir. The Department continued with the stocking plan for trophy trout fishery management by stocking only catchable-size trout. The occasional plants of sub-catchables and fingerlings were curtailed during this period to avoid increasing the food supply for pike. During this time, success of anglers fishing for trout dropped from 0.27 trout per hour in 1995, to 0.21 trout per hour in 1996, to 0.15 trout per hour in 1997. Anglers reported having pike attack hooked trout as they were being caught, and bite marks were observed on trout. However, this information was not quantified.

1997 to 2003

The Department decided on chemical treatment as the only viable means to eradicate northern pike. Lake Davis was treated in 1997. Following the treatment, hatcheries heavily stocked the reservoir and tributaries with millions of fingerlings, hundreds of thousands of sub-catchables, and several hundred thousand catchable-size Eagle Lake trout, including many trophy-size fish. Fingerling and trophy-size brown trout were also planted. Many thousands of brook trout fingerlings were stocked in several tributaries. The Department did not measure angler success during the first two years following the treatment, but surveys by the Department of Water Resources showed angler catch rate averaged 0.21 trout per hour in 1998.

In 1999, biologists once again confirmed the presence of pike in Lake Davis. Golden shiner, bullhead, bass, and pumpkinseed also were back in the reservoir. Since then, the Department has attempted to maintain the Lake Davis trout fishery while trying to control pike numbers using a variety of physical removal methods until a more permanent solution can be determined and agreed upon. Catchable-size Eagle Lake trout are planted at an allotment of 36,000-50,000 per year, depending on hatchery production and stock availability. Plantings of fingerlings and sub-catchables have been discontinued in order to reduce food supply for pike and to avoid waste of valuable, limited state resources. Angler surveys show that angling success has declined significantly ($P < 0.01$) from 0.28 trout per hour in 2000 to 0.12 in 2003 (Figure 6.) Anecdotal information from anglers also indicates that pike attacks on trout on the hook and bite marks on caught trout are being noted. The size of the trout caught by anglers has significantly increased ($P < 0.01$) (Figure 7). More study is needed to explain this trend, but in part it may be the result of pike consuming the smaller planted trout. Similar trends of decreasing angler success and increased size of rainbows caught by anglers were noted when pike occurred in the reservoir the first time.

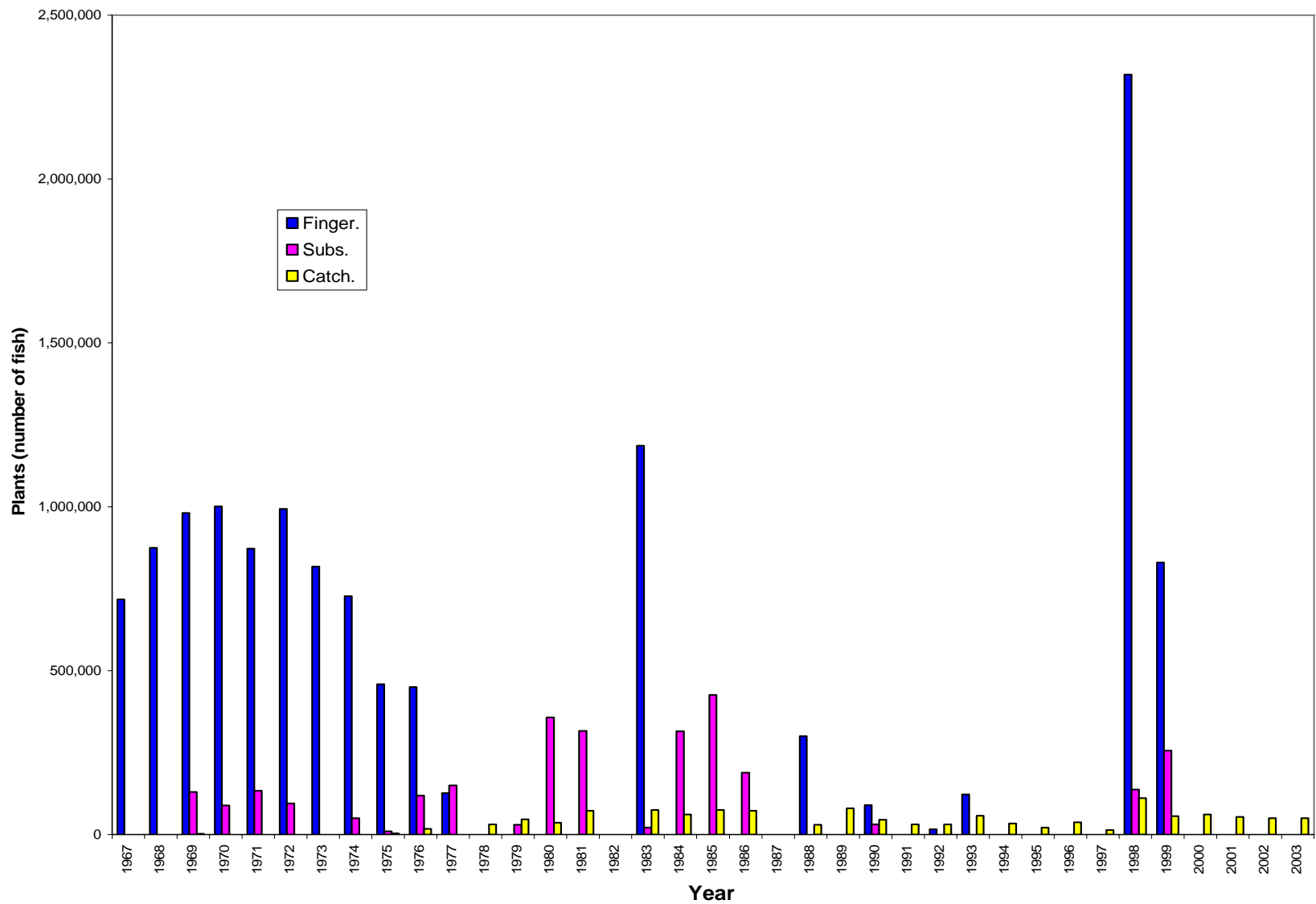


FIGURE 1 Number of rainbow trout planted annually to Lake Davis 1967-2003

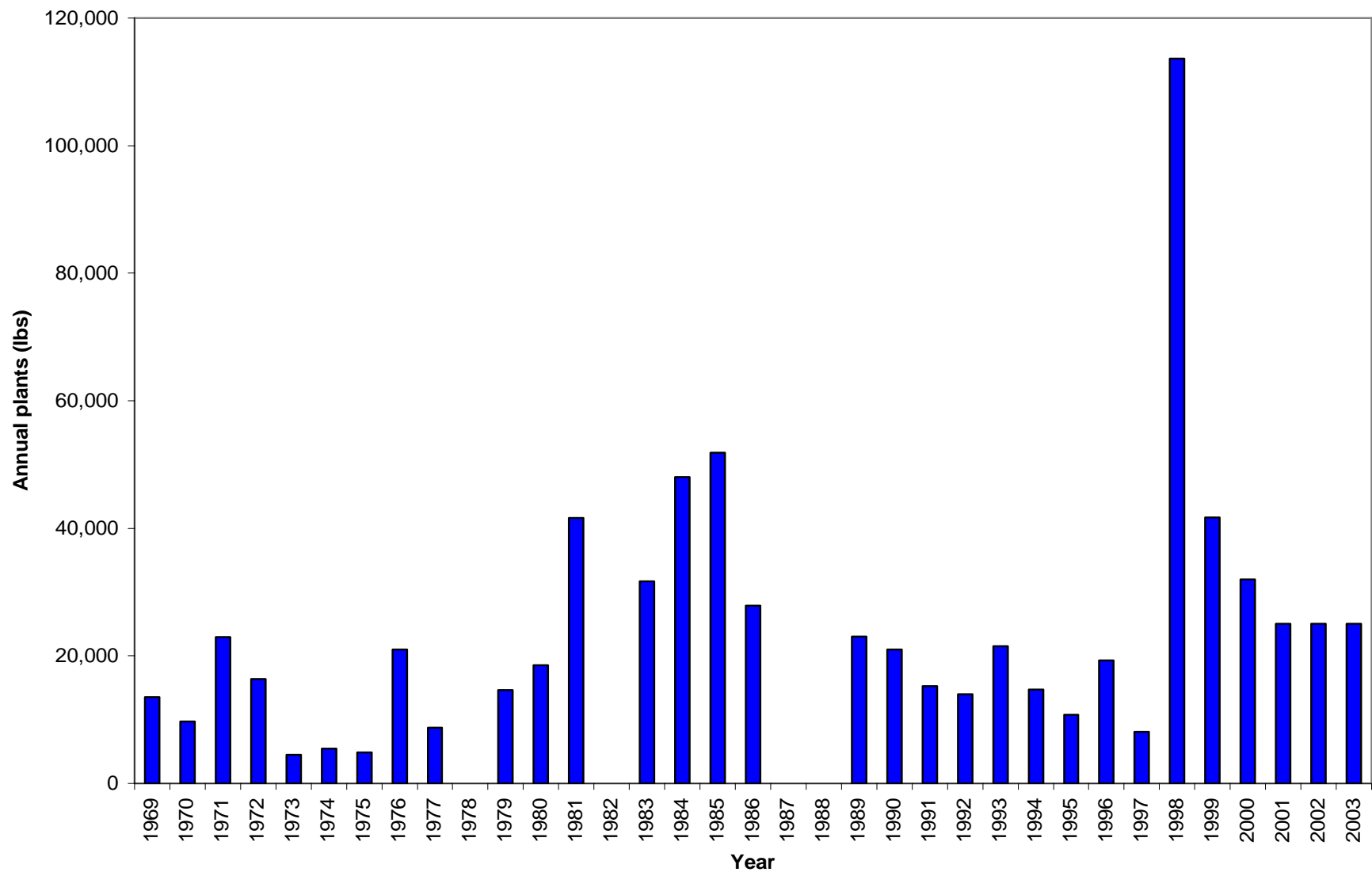


FIGURE 2 Total pounds of rainbow trout planted to Lake Davis annually 1969-2003

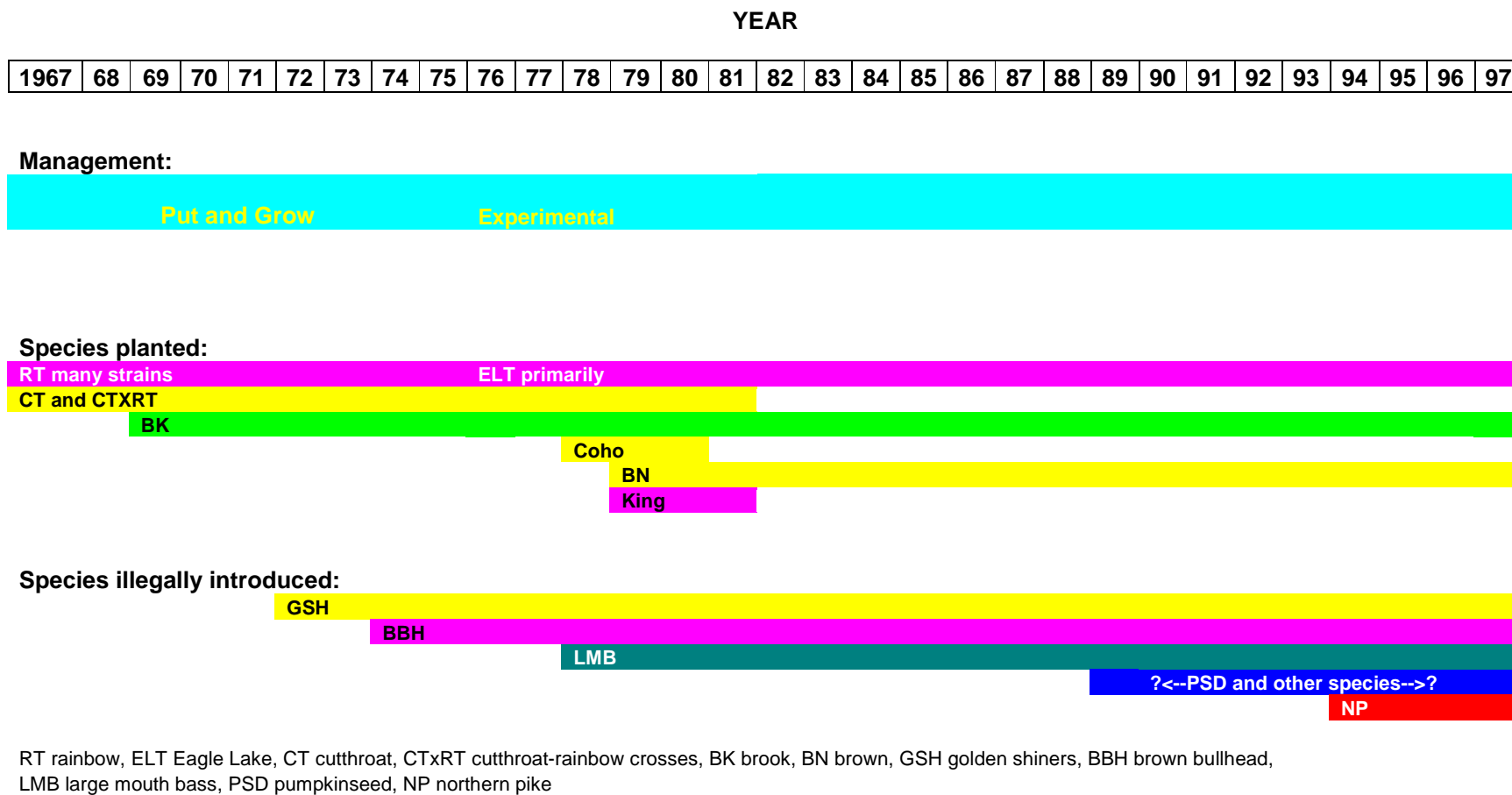


FIGURE 3 Timeline of management and fish species occurrence in Lake Davis 1967–1997

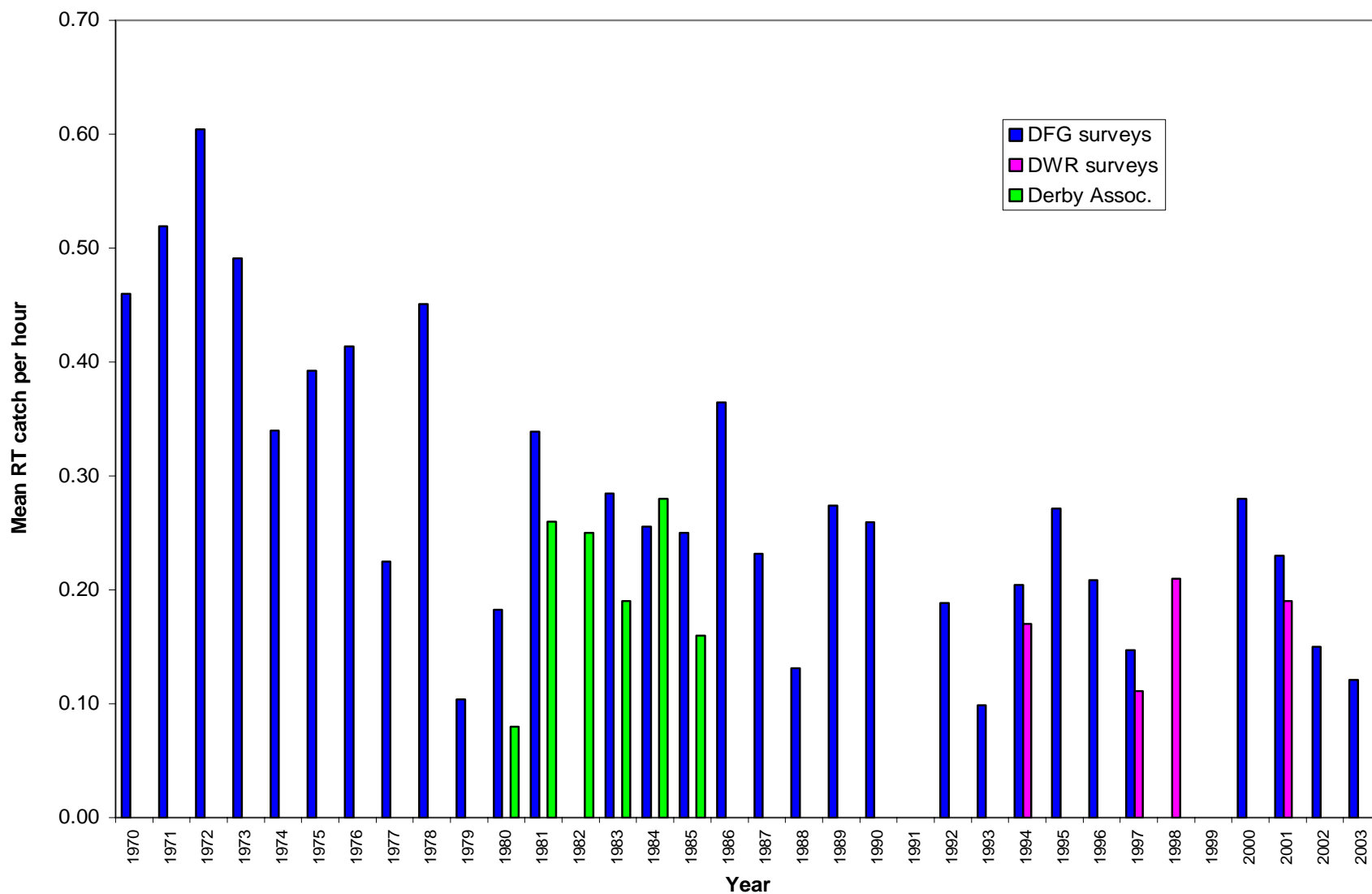


FIGURE 4 Comparison of angler catch per hour for rainbow trout 1970-2003
CA Dept. of Water Resources and Davis Derby Association provided angler survey data to the CDFG.

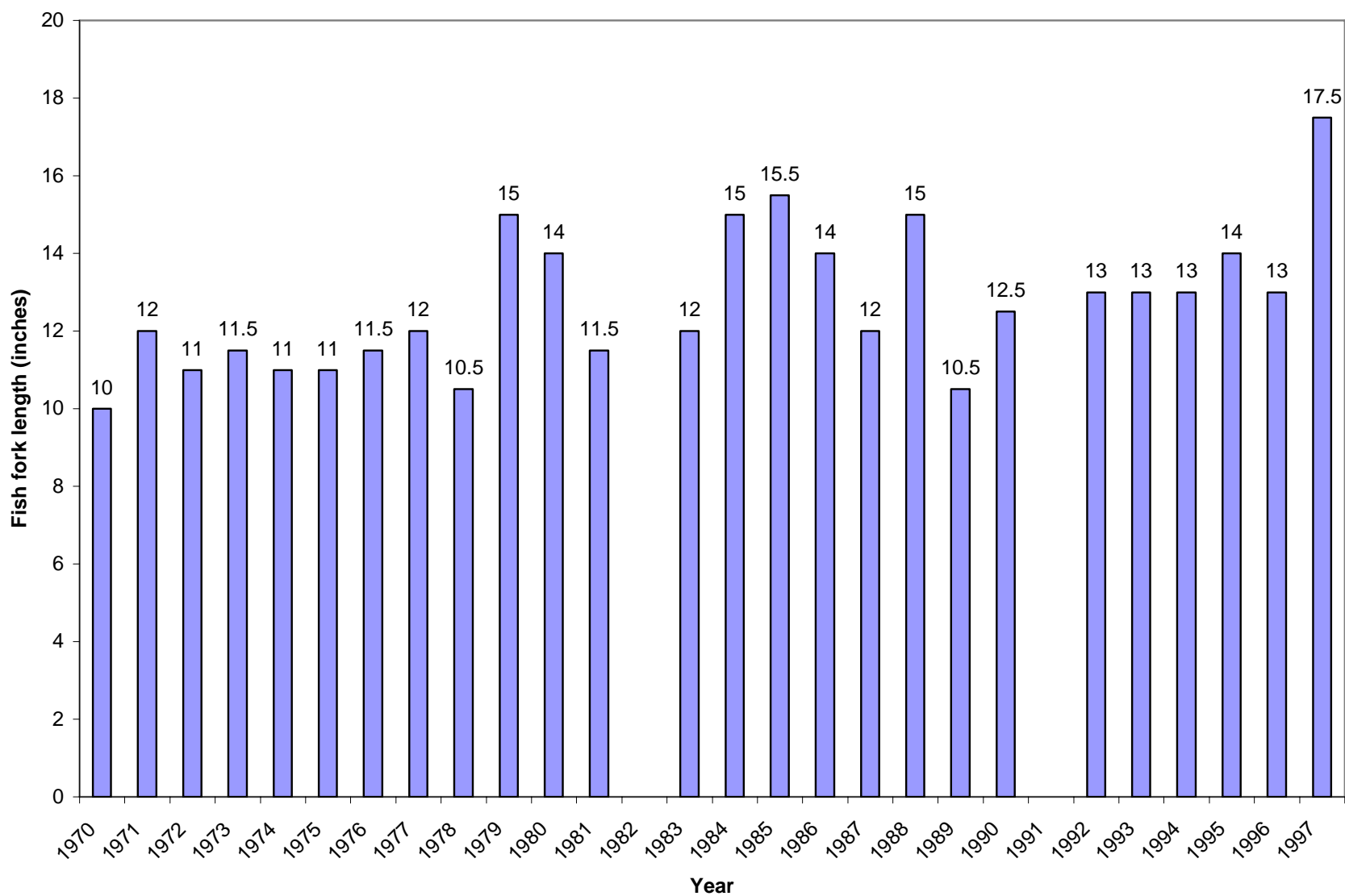


FIGURE 5. Comparison of mode length of angler-caught rainbow trout 1970-1997

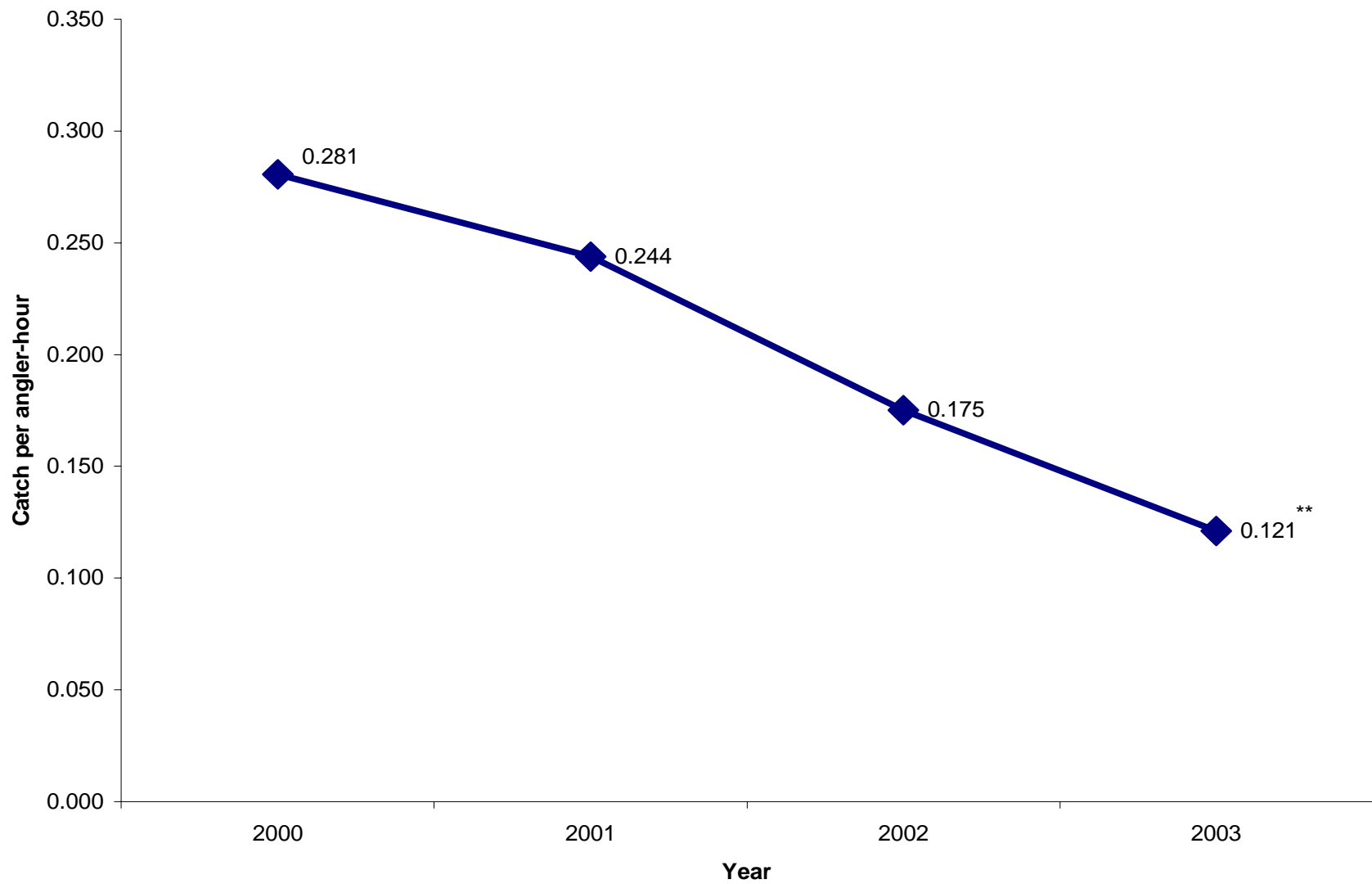


FIGURE 6 Comparison of angler catch rate for rainbow trout since the reappearance of northern pike in 1999

** Statistically significant decline in catch rate: $F_{(3, 1631)} = 9.28299$, $P < 0.01$

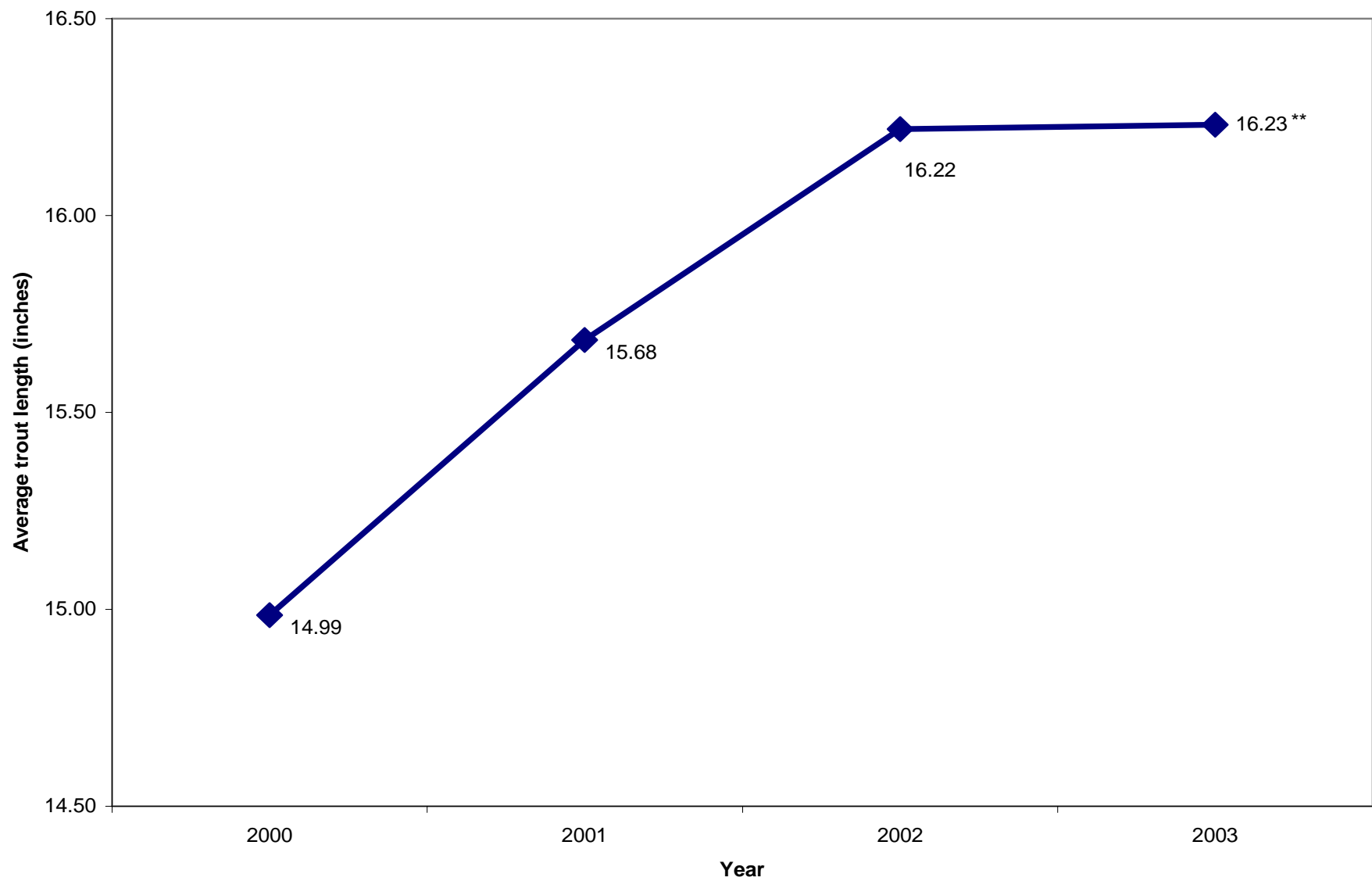


FIGURE 7 Comparison of angler-caught rainbow trout lengths since the reappearance of northern pike in 1999

** Statistically significant increase in angler-caught trout size: $F_{(3, 1578)} = 36.82784$, $P < 0.01$

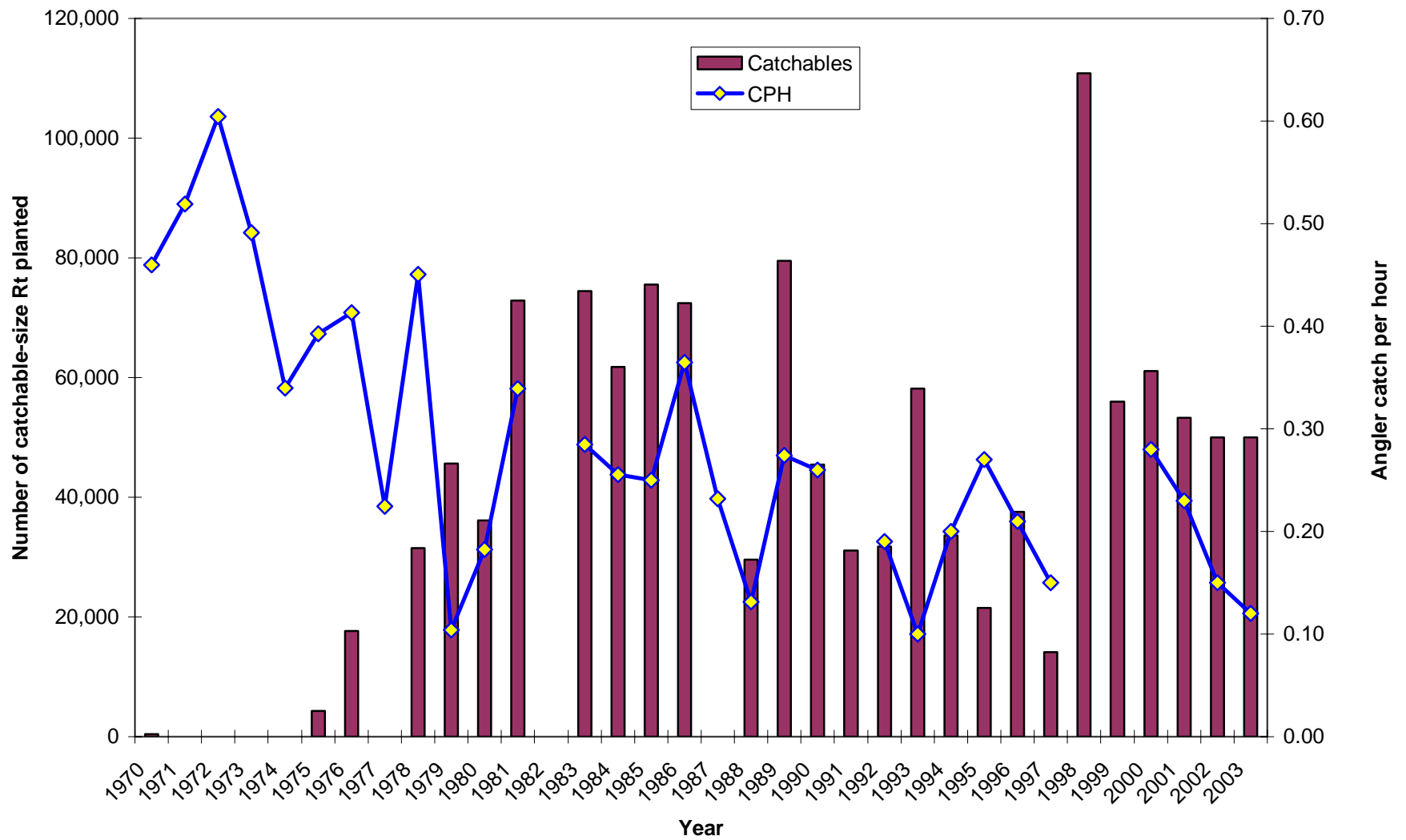


FIGURE 8 Comparison of number of catchable-size rainbow trout planted with the average angler catch-rate

Appendix A: Description of angler survey methods

There are a number of types of survey and census techniques used in fisheries management to try to estimate important aspects of a particular fishery. Some techniques estimate the total use of the reservoir (for example, the total number of anglers to use the reservoir in a year.) This differs from surveys that attempt to estimate the success of the anglers using the reservoir. The objectives of angler surveys conducted at Lake Davis and summarized here were to estimate the success of anglers in terms of the number of rainbow trout caught and the amount of time spent fishing and to estimate the average length of creeled fish. Creel surveys are important tools that provide necessary data for sound management of fisheries and provide opportunities for agency personnel to interact with the public to educate and gain support for ecological issues and activities. For recreational fisheries management, one important goal is to improve fishing success.

There are several different methods used to collect the data from anglers. The method used at Lake Davis has been roving random sampling. Because of limited personnel and equipment constraints, there have been some variations in annual surveys, such as in the number of days spent surveying anglers and whether boat anglers were surveyed from a boat or at the dock. In general, biologists surveyed anglers from April through November each year. Biologists roved the shoreline, the boat ramps, and other access points interviewing anglers. They gathered information on the number of anglers in the party, the number of hours fished, and the number of each species caught and kept. Creeled fish were counted, and lengths were measured.

Because angler surveys are very labor intensive, it is usually not possible to interview every angler that fishes a lake or reservoir during a year. We have to settle for a subset or sample to estimate the average angler success and total use of the fishery. In order for a sample to provide the best estimate of the “real world”, we need to reduce bias in our sampling technique. We do this by randomly selecting days to conduct surveys and randomly choosing anglers to interview. We move about the reservoir so that we are interviewing anglers that have fished different areas of the reservoir. We interview anglers throughout the day so that we are sampling morning, afternoon, and evening effort. We conduct surveys on weekdays, weekends, and holidays in spring, summer, and fall. We use basically the same system and techniques each day that we run a census. By standardizing our methods and randomly choosing days and anglers, we try to prevent bias such as selectively including or excluding certain classes of anglers. Theoretically, each angler has an equal opportunity to be included in the survey.

Fishing success is generally measured as the number of fish caught per hour. The basic unit of recreational fishing effort is the angler-hour (1 hour of fishing by a single angler.) Fishing success is measured as the catch per unit of fishing effort (CPUE) or catch per hour (CPH). Both of these success measures are calculated with the formula:

Number of fish creeled ÷ number of angler-hours = CPUE (or CPH)

(Only the fish caught and kept are counted in the survey, although reports of fish caught and released are recorded for other purposes.)

Examples:

1 angler fishes 4 hours and creels 3 trout → CPUE or CPH is $\frac{3}{4} = 0.75$

3 anglers in party fish 2 hours together and creel 1 fish total
angler-hours = $3 \times 2 = 6$ → CPUE or CPH is $1/6 = 0.17$

Once the CPUE is determined for each angler, the average CPUE is calculated for the year.

Example:

10 CPUE →	0.5
	0.5
	0.3
	0.1
	0.2
	0.1
	0.4
	0.2
	0.1
	<u>0.9</u>
Total	3.3

divided by 10 → average CPUE for year = 0.33

(Note that angler success per individual varied from 0.1 to 0.9)

The annual averages can then be compared using statistical analyses. Statistical analyses can indicate whether results are nearly the same each year or whether there is a difference. A comparison that is “statistically significant” means that the difference is not very likely to be due to “chance.” In other words, $P < 0.01$ means that there is a greater than 99% chance that the results are “real” and not just due to “luck of the draw” in sampling. Statistics don’t tell us what the causes are, just that there is likely some real explanation for the pattern observed.